ATTACHMENT 1

Comments on the Intake Dam DEIS
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7/21/16

I. Introduction

The Draft Environmental Impact Statement (DEIS) examines six alternatives: 1) No Action, 2) Rock Ramp, 3) Bypass Channel, 4) Modified Side Channel, 5) Multiple Pumps, and 6) Multiple Pumps with Conservation Measures. Of those, the No Action Alternative does nothing to improve fish passage. According to the DEIS, the Rock Ramp Alternative and Modified Side Channel Alternative are each either more expensive than or environmentally inferior to the Bypass Channel Alternative, and the Conservation Measures Alternative produces the same level of fish passage benefits as the Multiple Pumps alternative but at more than twice the cost.[1] Thus, the DEIS rejects each of those four alternatives as inferior to at least one of the other alternatives.

The remaining two alternatives, the Bypass Channel Alternative and the Multiple Pumps Alternative, involve tradeoffs. According to the DEIS, the Multiple Pumps Alternative produces 55% more fish passage benefits than the Bypass Channel Alternative,[2] but costs 105 percent more.[3] The rest of this analysis will focus on those two Alternatives, identify adjustments that should be made to the DEIS cost numbers that should change these conclusions, and highlight other potential ways of reducing the costs of the Multiple Pumps Alternative.   This analysis does not address the wisdom or the legal implications of choosing an alternative based on the chosen cost/benefit analysis. Rather, this analysis only addresses the validity of the inputs used and the DEIS's conclusions regarding the relative costs of these two alternatives.

II. Summary of conclusions

The DEIS identifies the Bypass Channel Alternative as the preferred alternative primarily based on the conclusion that it is the most cost-effective alternative. However, the DEIS's cost/benefit analysis relies on unsubstantiated assumptions that undermine its

[1] Appendix D, p. 20, Table 2-3.
[2] Ibid. 11,011/7,116 = 1.547, or a 54.7% difference.
[3] Ibid. $10,594/$5,170 = 2.047, or a 104.7% difference.

conclusions. Once the costs for the Bypass Channel Alternative and Multiple Pumps Alternative are adjusted to reflect these erroneous assumptions, the cost per habitat unit – the DEIS's measurement of benefits to pallid sturgeon – is **lower** for the Multiple Pump Alternative than the Bypass Channel Alternative. Thus, the agencies' basis for choosing the Bypass Channel Alternative is not supported by the information provided in the DEIS.

As described in more detail below and in the accompanying spreadsheet, the DEIS's economic conclusions are undermined in the following ways:

(1) The DEIS's conclusion overstates the economic benefits of the Bypass Channel Alternative (section III) in several significant ways, including:

- The DEIS lumps the benefits of the Bypass Channel Alternative for pallid sturgeon with 13 other species of fish to obtain a Fish Passage Connectivity Index (FPCI, the key measure in the DEIS for benefits to fish) average value (0.67) that is higher than the FPCI for pallid sturgeon alone (0.6) (sections III.B and C);
- There is a crucial inconsistency between the April 2015 Final Supplement to the 2010 Final Environmental Assessment ("Supplemental EA") and the DEIS, the former of which gave the Bypass Channel Alternative an FPCI value of only 0.5 (section III.D.1). The increase in the FPCI for pallid sturgeon between the 2015 EA and the DEIS results from manipulation of the Fl variable, which was changed between the documents from a "3" to "4" value, with no acknowledgement or justification for the change (section III.D.1);
- This in turn affects the value/increased habitat unit profoundly. Using the F1 variable from the Supplemental EA renders the Bypass Channel Alternative more expensive on a cost/habitat unit basis (a key cost criterion in the Draft EIS) than the Multiple Pumps Alternative (section III.D.1).

(2) The DEIS understates the capital and operating and maintenance (O&M) costs of the Bypass Channel Alternative (section IV.A).

(3) The DEIS overstates the capital and O&M costs of the Multiple Pumps Alternative (section IV.B).

(4) Quantifying most of the overstated cost of the Multiple Pumps Alternative (and some of the understatement of the cost of the Bypass Channel Alternative), the

incremental cost of the fish passage benefits from going from No Action to the Bypass Channel Alternative is still less than the incremental cost of the benefits gained by going from the No Action Alternative to the Multiple Pump Alternative (section V.B). However, the DEIS fails to note that the sensitivity results of its model are based entirely on the assignment of an upwardly-revised numeric value to fish attractiveness for the Bypass Channel Alternative, and that using that most optimistic assignment of attractiveness in turn results in a lower cost/habitat unit improvement than the Multiple Pumps Alternatives. Using the 2015 EA assignment value for F1, and more accurate adjustments for cost, results in the conclusion that the Multiple Pumps alternative is superior on a cost/habitat unit basis.

(5) The DEIS further overstates costs of the Multiple Pumps Alternative by failing to analyze ways that using fewer pump sites might reduce the cost substantially (sections VI and VII).

(6) The DEIS contains a number of other analytical errors that ignore costs associated with the Bypass Channel Alternative, including rock removal, and tend to inflate the cost of the Multiple Pumps Alternative (sections IV.A.1., VIII.C-D).

III. DEIS benefit/cost methodology

A. Compares levelized cost to increase in annual average habitat units (AAHUs)

The DEIS measures the benefits to fish of improved passage at Intake in "habitat units" or "HUs," which are also referred to as "annual average habitat units" or "AAHUs." A habitat unit is simply the number of acres of habitat upstream of Intake times the likelihood that the alternative in question will provide access to them. For every alternative, the number of acres of upstream pallid sturgeon (also referred to below as simply "sturgeon") habitat is the same, 12,637 acres,[4] and thus the maximum possible number of sturgeon HUs for any alternative is 12,637. The probability that an alternative

[4] Appendix D, p. 4, Table 1-1.

will allow fish to pass upstream of Intake is measured by what the DEIS calls the "Fish Passage Connectivity Index," or FPCI. The FPCI varies by alternative, from 1.0 (100%) for the no-weir alternatives[5] to a minimal 0.0252 for the No Action Alternative.[6] Thus the number of sturgeon HUs varies from a low of 318 for the No Action Alternative to a high of 12,637 for the no-weir alternatives. Variations in HU between alternatives are driven entirely by the variation between alternatives of the FPCI component of the HU calculation.

The DEIS then calculates how much each alternative will increase the number of HUs as compared to the No Action Alternative. Thus, the no-weir alternatives would increase the number of pallid-sturgeon specific HUs by 12,319.[7]

The DEIS then divides the annualized cost of each alternative by the increase in HUs for that alternative to produce a cost per AAHU for each alternative. Thus, the Multiple Pump Alternative, using DEIS numbers, would have a cost for improved sturgeon habitat of $10.595 million for an HU increase of 12,319, or a cost per AAHU of $860.

B. The HU numbers reported in the DEIS inappropriately all but ignore pallid sturgeon

The DEIS methodology as described above used examples based on the DEIS data for sturgeon. But the DEIS itself inappropriately measures HUs and cost per AAHU differently. Even though the reason for the proposed action is to "improve fish passage for pallid sturgeon,"[8] the DEIS lumps sturgeon in with 13 other species in calculating HUs and cost per AAHU.[9] Sturgeon benefits thus get a weight of only 1/14 in calculating HU benefits.[10]

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[5] DEIS, p. 2-99, Table 2-27.
[6] The DEIS calculates the FPCI based on a composite of 14 different fish species, as described in Section III.B. The figures used here are calculated from parameters for pallid sturgeon only in Appendix D, pp. 11-12 and 14-15. [(2+5)/2]*1*0.18/25 = .0252. See the attached spreadsheet, "Cost per AAHU" tab.
[7] 12,637 (sturgeon HUs for the no-weir alternatives) minus 318 (sturgeon HUs for the No Action Alternative) equals 12,319.
[8] DEIS, p. 1-6.
[9] Appendix D, p. 4, Table 1-1.
[10] Appendix D, p. 2, formula showing that the HUs for each species are weighted equally.

The fallacy of the DEIS approach, as a statistical matter, can be seen by imagining what would happen if the proposed action, the Bypass Channel Alternative,[11] would not allow any pallid sturgeon passage whatsoever, but passage for other species was unaffected. In that case, the HUs for the Bypass Channel Alternative would be reduced by about 1/14, since the sturgeon-specific HU would drop to zero but the HUs for the other 13 species would stay the same. That would increase the cost per AAHU for the Bypass Channel Alternative by about 1/14, or about 7 percent. The DEIS methodology would still conclude that the Bypass Channel Alternative is the most cost-effective![12]

A methodology in which an Alternative that provided no sturgeon passage could be rated the most cost-effective is an absurd methodology. The DEIS should have used sturgeon-specific data to calculate HUs and costs per AAHU, with any impacts on other species identified as required by NEPA, but not used to drive the policy choice. The analysis below uses sturgeon-specific data whenever it calculates HUs or costs per AAHU.

C. Focusing HU measurement on sturgeon reduces the HU benefit of the Bypass Channel Alternative relative to the Multiple Pumps Alternative

As described above (section IV.A), variations in HU between alternatives are driven entirely by variations in the FPCI between alternatives. For the Multiple Pump Alternative, the FPCI is 1 for all fourteen species, and thus the sturgeon FPCI of 1 is the same as the composite FPCI reported in the DEIS. For the Bypass Channel alternative, however, the sturgeon FPCI is lower than the all-species FPCI. The DEIS calculates an FPCI for all fourteen species together of 0.674.[13] But the sturgeon-specific FPCI for the Bypass Channel Alternative, using the data in the DEIS, is 0.600.[14] Thus, using a

[11] DEIS, p. 2-105.
[12] DEIS, p. 2-100, showing a Bypass Channel cost per AAHU of $727. Increasing that number by 7 percent would increase it to $778/AAHU, which would still be less than the cost of the next cheapest alternative. Thus the Bypass Channel Alternative would remain the most cost-effective, according to the DEIS's flawed methodology.
[13] DEIS, p. 2-99, Table 2-27, showing average HUs of 8,054 for the Bypass Channel Alternative and 11,949 for the two no-weir alternatives. 8,054/11,949 = .6740, which the DEIS rounds off to .67 for display purposes (while using the .674 figure for calculation purposes).
[14] Appendix D, pp. 2 and 10 (formulas for calculating FPCI), and pp. 11-12 and 13-14 (sturgeon-specific values for the inputs into the FPCI formula). The resultant sturgeon-specific FPCI is [(2+4)/2]*5*1/25 = .6.

sturgeon-specific FPCI reduces the HU for the Bypass Channel Alternative by some 11 percent.[15]

With an FPCI of 0.6, the Bypass Channel Alternative produces only 60 percent as many HUs as the no-weir alternatives with their FPCI of 1.0. The net improvement in fish passage is even less than that, because (according to the DEIS), there is already some fish passage occurring under the No Action Alternative. When the small sturgeon passage the DEIS attributes to the No Action Alternative is considered, the net benefits of the Bypass Channel Alternative are even smaller, only 59 percent of the net benefits of the Multiple Pump Alternative, using DEIS data.[16]

D. The DEIS may be overstating the benefits to sturgeon of the Bypass Channel Alternative when it says they will have a FPCI of 0.600

1. DEIS vs. Supplemental EA

Just last year, the 2015 Supplemental EA said the FPCI for pallid sturgeon of the Bypass Channel alternative was only 0.5,[17] or only half of the FPCI in the DEIS for Multiple Pumps.[18] The DEIS neither acknowledges nor explains why it now shows an FPCI for sturgeon 20% larger than the Supplemental EA of 2015. Comparing the two documents, the basis for the higher FPCI in the DEIS is an increase in the forecast value for Fl. Fl is a variable which represents the probability of sturgeon finding the proposed bypass, with 1 lowest, 5 highest, and 3 corresponding to a 50 percent probability.[19] Fl was 3 (out of a maximum of 5) in the Supplemental EA,[20] but has been increased by 33 percent, to 4, in the DEIS.[21] That single change raises the overall FPCI for sturgeon from

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[15] 0.600/0.674 = .890 = 89%, for a reduction of 11 percent.
[16] See the attached spreadsheet, “Cost per AAHU” tab, calculating sturgeon-specific HUs and the increase in HUs (compared to the No Action Alternative). The Bypass Channel Alternative produces 7,264 sturgeon HUs more than the No Action Case, while the no-weir alternatives produce 12,319 more HUs than the No Action Alternative. 7,264/12,319 = .5897 = 58.97 percent.
[17] Supplemental EA, Appendix E, Attachment 1, “Fish Passage Benefits Analysis,” p. 23, Table 10.
[18] See the attached spreadsheet, “Cost per AAHU” tab, line 3, for the FPCI for the Multiple Pump Alternative as calculated using DEIS data and DEIS methodology.
[19] Appendix D, p. 10.
[20] Supplemental EA, Appendix E, Attachment 1, “Fish Passage benefits Analysis,” p. 16, Table 6.
[21] Appendix D, p. 11, Table 1-7.

0.5 in the Supplemental EA to 0.6 in the DEIS. The DEIS neither acknowledges nor explains why it now shows an Fl value for sturgeon that is 33% larger than the value in the Supplemental EA of 2015. Instead, the DEIS claims that it is using a value from "Corps (2014),"[22] a date earlier than the Supplemental EA, which used a value of 3. If the FPCI for the Bypass Channel Alternative should have remained at 0.5, then the DEIS has overstated the sturgeon-specific HUs for the Bypass Channel Alternative by 20 percent.[23]

The impact of this arbitrary conversion is profound in terms of the results of the analysis. If the FPCI resulting from the choice of F1 of 3 instead of 4 is 0.5, as was used in the 2015 EA, then the cost per AAHU jumps to $876, less cost effective than the Multiple Pumps Alternative using either three or five pumps.[24] If, in fact, the F1 value is actually 2 instead of 3, the FPCI becomes 0.4 and the cost per AAHU jumps to $1,110.[25] That the choice of F1 is highly subjective and that the uncertainty is not explicitly identified in assigning this value has been criticized in previous peer reviews of this methodology.[26] At the very least, the range of uncertainty suggests that from a cost effectiveness perspective, a higher cost per AAHU for the Bypass Channel over any combination of Multiple Pumps would invariably result if this were modeled statistically.

2. The actual FPCI may be lower than either 0.6 **or** 0.5

Whether the DEIS methodology should produce an FPCI of 0.5 or 0.6 for sturgeon may, however, be a moot question. The DEIS contains minimal evidence of the ability/willingness of sturgeon to use natural bypass channels, and the ability/willingness of sturgeon to use artificial bypass channels.[27] To the extent that sturgeon will be more than twice as likely to use a weir-free river as to use an artificial side channel with flows

[22] Appendix D, p. 10.
[23] 0.6 / 0.5 = 1.20, or an increase of 20 percent.
[24] See the attached spreadsheet, "Cost per AAHU" tab, lines 2a-4, which calculates sturgeon-specific FPCI and HU values for the Multiple Pump and Bypass Channel Alternatives, using the formulae in Appendix D, pp. 2 and 10, and the sturgeon-specific data in Appendix D, pp. 11-12 and 14-15.
[25] Id, line 2b.
[26] See, 2013 Battelle Peer Review, Final Independent External Peer Review Report for the Intake Diversion Dam Modification Lower Yellowstone Project, Montana Draft Supplement to the 26 April 2010 Environmental Assessment and Appendices by Battelle, 505 King Avenue, Columbus, OH 43201 for Department of the Army, U.S. Army Corps of Engineers, Ecosystem Restoration Planning Center of Expertise for the St. Paul District, February 8, 2013 (cited below as "Battelle").
[27] DEIS, pp. 2-105 to 2-108.

80+ percent smaller than main river flows, then the real FPCI will be below 0.5.[28] A 2013 analysis suggested that a bypass channel originating near the toe of the dam, as proposed in the DEIS, "appears to have a limited probability of success….The probability that the preferred alternative will perform as proposed is very low based on the scientific information presented, the number of project uncertainties and risks, and concerns regarding the sustainability of the bypass channel."[29] The DEIS does not consider the possibility that the FPCI for the Bypass Channel Alternative will be less than 0.5, which undermines the validity of its cost calculations.

IV. DEIS benefit/cost results

A. Bypass Channel Alternative

1. Cost

The DEIS estimates the annualized cost of the Bypass Channel Alternative will be $5.171 million per year.[30] That cost includes post-construction monitoring for 8 years,[31] but no costs for post-construction modifications based on the results of monitoring. The DEIS acknowledges that in the Bypass Channel alternative (unlike the no-weir alternatives), there is a "moderate" likelihood that adaptive management will be required once actual post-construction operations have been observed.[32] The Supplemental EA published last year also suggested that adaptive management could require a variety of changes to the Bypass Channel once it was operational as more was learned about actual use (or non-use) of the newly constructed channel by pallid

[28] The DEIS shows the FPCI for a weir-free river as 1.0. Thus the sturgeon FPCI for the Bypass Channel Alternative is simply the ratio of the number of sturgeon that would use the proposed bypass channel compared to the number of sturgeon that would use a weir-free main river. If more than twice as many sturgeon would choose a weir-free river over an artificial bypass channel, then that ratio is less than one out of two, and the Bypass Channel Alternative FPCI is less than 0.5.
[29] Battelle p. A-6.
[30] DEIS, pp. xxxii and 2-99.
[31] Appendix B, pdf p. 167 of 173.
[32] DEIS, p. 2-103.

sturgeon.[33] The EA priced four such adaptive management measures that could be required for the Bypass Channel Alternative as a result of monitoring, and quantified their costs at an annualized $170,000 per year.[34] A review of an earlier version of the EA suggested that the proposed bypass channel originating from the base of the dam was at risk of being “inundated” and suffering “scour damage and potential sediment deposition” during an overbank flood event, calling into question its “sustainability.”[35] It concluded that for the “proposed bypass channel … some form of encouragement or form of guidance may be necessary to have the migrating pallid sturgeon find and enter [the bypass] channel.”[36] Both of these problems (damage to the bypass channel during floods, and failure of pallid sturgeon to find or use the inlet to the bypass channel) are additional sources of future adaptive management costs.

Failure to account for such post-construction adaptive management costs means the true costs of Bypass Channel Alternative are likely to be higher (possibly much higher) if the initial design fails to entice sturgeon to enter and pass through the newly-built bypass channel. Even if only half the adaptive management costs quantified in the Supplemental EA are added to the DEIS’s forecast of the cost of the Bypass Channel Alternative, which would raise its annualized cost from $5.171 million per year[37] to $5.256 million per year.

2. Benefits for sturgeon

The sturgeon-specific increase in habitat units for the Bypass Channel Alternative, per the data in the DEIS, is 7264, based on a No Action HU of 318 and a Bypass Chanel Alternative HU of 7582.[38]

3. Cost per unit of HU increase

[33] Supplemental EA, Appendix E, pdf pp. 302-3 of 426.
[34] Supplemental EA, Appendix E, pdf p. 303 of 426.
[35] Battelle, p. A-3.
[36] Ibid.
[37] DEIS, pp. xxxii and 2-99.
[38] See the attached spreadsheet which calculates sturgeon-specific FPCI and HU values for the No Action and Bypass Channel Alternatives, using the formulae in Appendix D, pp. 2 and 10, and the sturgeon-specific data in Appendix D, pp. 11-12 and 14-15.

The cost per AAHU of the Bypass Channel Alternative would be $724, based on the increase in sturgeon-specific HUs from the No Action Alternative to the Bypass Channel Alternative, and the DEIS cost of the Bypass Channel Alternative plus half the Supplemental EA cost for specific adaptive management measures for the Bypass Channel Alternative.[39] However, as noted above, it would be $876 if the FPCI value from the 2015 EA were used,[40] and may be as high as $1,110 if uncertainty of the fish passage benefit is included in the calculation.[41]

B. Multiple Pumps alternative

The DEIS projects an annualized cost for the Multiple Pumps Alternative of $10.595 million per year.[42] However, this cost projection needs to be adjusted for a variety of ways in which the DEIS has either overforecasted costs or included unnecessary equipment (and thus costs) in its description of the scope of the Multiple Pumps Alternative.

1. Operating cost is overstated due to errors in calculating pumping energy requirements, and hence pumping energy cost - $111,000 per year

a. The DEIS assumes too high of a water diversion requirement

The DEIS assumes that the average amount of water diverted will be 1100 cfs over the 5-month period from May-September[43] (April water use does not require pumping, but can rely on gravity diversions). The 1100 cfs figure is overstated because of rounding; the DEIS itself says the actual number is 1078 cfs.[44] But even the 1078 cfs

[39] See the attached spreadsheet, "Cost per AAHU" tab, line 2, which calculates sturgeon-specific FPCI and HU values for the No Action and Bypass Channel Alternatives, the cost of the Bypass Channel Alternative including an adjustment for adaptive management, and the resultant cost per AAHU.
[40] Id., line 2a.
[41] Id., line 2b.
[42] DEIS, p. xxxii, Table ES-1, and p. 2-99.
[43] Appendix A, pdf p. 204 of 527.
[44] Ibid.

figure is incorrect; the 42-year average is below 1000 cfs, and the average for the most recent 11 years of data is 1044 cfs.[45]

b. The DEIS assumes unnecessarily lumpy pumping increments

The DEIS assumes that as water diversions by gravity drop, the amount of water needed to be pumped will grow by 275 cfs increments, reflecting the pumping capacity at each site. But each site will have three separate pumps (actually four in the DEIS, but the fourth one is a spare). So even if pumps have to be used in an all-or-nothing mode (which may not be true), the amount of pumping is still controllable to 92 cfs steps, rather than 275 cfs steps. That reduces the amount of pumping required by a considerable amount.

c. The DEIS assumes pumps are operated in an inefficient manner

The DEIS points out that when pumped water is being delivered to the main canal above the check structure called Burns Creek Overchute, tailwater effects will make it impossible to simultaneously divert water by gravity flow at Intake. But the converse is also true: when pumped water is being delivered below Burns Creek Overchute, it will be possible to simultaneously divert water at Intake.[46] Of the five proposed pump sites, two would deliver to the Main Canal above Burns Creek Overchute (although the site 2 delivery point is less than one mile above Burns Creek Overchute,[47] and thus could potentially be moved to solve this problem). The DEIS acknowledges that all three of the downstream pump sites could be operating at their full 825 cfs capacity without simultaneously impairing gravity diversions of up to 550 cfs at Intake. Thus it would certainly be possible to operate any one of the lower three sites without impairing gravity diversions at Intake. The DEIS incorrectly assumes that when only one pump site is being used, it would have to be the farthest downstream one. If Site 3 pumps were used before Site 4 or 5 pumps, pumping costs would be reduced because Site 3 requires less pumping energy per cfs pumped than sites 4 or 5.

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[45] See the attached spreadsheet, "Historical diversions" tab.
[46] Appendix A, pdf p. 200 of 527.
[47] Ibid.

d. The DEIS does not address monthly variations in both hydrology and irrigation requirements

The DEIS models the level of pumping energy based on average diversion requirements across the full 5-month season and gravity diversion capability across the full 5-month season. The DEIS presents, but does not use, data on monthly gravity diversion capability. The Federal agencies have also previously provided monthly diversion data for 28 historical years. Thus data exists to allow the pumping requirement calculations to be done on a month-by-month basis, which is more accurate.

e. Altogether, the DEIS overestimates pumping loads by more than 28 percent

Correcting for the overstated average diversion requirements in the DEIS, the DEIS's failure to account for the presence of three pumps at each pumping site, and the DEIS's assumption that the most costly site will have to be used first (rather than third), and then modeling pumping requirements separately for each month, the overall average pumping requirement turns out to be 7.85 gwh per year, not the 10.1 gwh asserted in the DEIS.[48] The DEIS has overstated pumping energy requirements by at least 28 percent.[49] Based on the DEIS's forecasted cost of $500,000 per year for 10.1 gwh, the savings from the lower actual pumping requirements would be $0.111 million per year,[50] and pumping costs would be reduced to $389,000 per year.[51]

2. Capital cost is overstated due to piping length for pump site 3 - $0.568 million

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[48] See the attached spreadsheet, "Flows with no dam, 5 pump sites" tab, Excel cell BC40.
[49] 10.1/7.853 = 1.286, for an overstatement of 28.6 percent. The "at least" is because the calculations do not account for the possibility of running individual pumps at less than 100 percent of their capacity.
[50] $500,000 x (10,100 – 7853)/10,100. See the attached spreadsheet, "Multiple Pump costs" tab, line 9.
[51] $500,000 - $111,000 = $389,000.

The DEIS proposes a 5600 feet long pipe to deliver water from pump site 3 to the Main Canal, using a convoluted route.[52] Eliminating the long east-west section along County Route 103 would cut the pipe length by about 2600 feet,[53] or almost 50%, thereby reducing its cost by $429,000.[54] Because the Multiple Pump Scenario includes an additional 32.46% contingency for discharge pipeline costs,[55] the reduction in the total DEIS cost for reducing the Site 3 piping length would be $429,000 x 1.3246 = $568,000.[56] This is just the reduction in costs for the pipe itself, and does not include additional savings in installation costs, which were not quantifiable from the data in the DEIS.

3. Capital cost is overstated due to piping length for pump sites 4 and 5 - $0.437 million

The DEIS proposes to reduce the cost of pumping sites 4 and 5 by having a common outlet structure to deliver their water to the Main Canal,[57] which seems reasonable. However, the proposed location of the outlet structure requires about 1400 linear feet of parallel piping from where the two outlet pipes reach each other to where they would reach the outlet structure.[58] Locating the outlet structure directly inland of pump site 4 would shorten that parallel pipe distance to about 400 feet,[59] thus savings a total of 2000 feet of piping (1000 for each pump site). It would also save the cost of an inverted siphon on lateral HH where it would need to pass under the outlet pipes,[60] which have not been quantified here. The capital cost savings would be $330,000.[61] Because the

[52] Appendix A, pdf p. 228 of 527.
[53] Ibid.
[54] $100 per linear foot, per document BOR-0005749/50. $100/linear foot is a 2013 estimate for 54" diameter pipe, per Attachment 1 to Agency data response of 12/22/15. Scaling up linearly for 84" pipe proposed at Site 3, plus 6% for 2013-2016 inflation, yields $165 per linear foot for 84 inch diameter pipe. 2600 feet x $165/foot = $429,000.
[55] Appendix B, pdf p. 84 of 173.
[56] See the attached spreadsheet, "Multiple Pump costs" tab, line 1.
[57] According to the map in Appendix A, pdf p. 230 of 527.
[58] Appendix A, pdf p. 230 of 527.
[59] Appendix A, pdf p. 229 of 527.
[60] Appendix A, pdf pp. 229 and 316-317 of 527.
[61] $100 per linear foot, per document BOR-0005749/50. $100/linear foot is a 2013 estimate for 54" diameter pipe, per Attachment 1 to Agency data response of 12/22/15. Scaling up linearly for 84" pipe

Multiple Pump Scenario includes an additional 32.46% contingency for discharge pipeline costs,[62] the reduction in the total DEIS cost for reducing the Sites 4 and 5 piping length would be $330,000 x 1.3246 = $437,000.[63] This is just the reduction in costs for the pipe itself, and does not include additional savings in installation costs, which were not quantifiable from the data in the DEIS.

4. Capital and operating costs are overstated due to the inclusion of unnecessary backup equipment

a. Back-up pumps: $2.987 million of capital and $178,000 per year of OM&R costs

The DEIS includes capital costs for back-up pumps at all five sites, as protection against one of the three pumps at each site failing. However, if a pump fails at one site, backup pumping can be supplied from the other sites. Only if all five sites are already operating, and all three pumps at each site are already operating, would a pump failure be unreplaceable from increased pumping at another site.[64] Even then, diversions of 1283 cfs would still be possible using the 14 remaining pumps.

The DEIS provides daily diversion levels for only two years, 2000 and 2012, which were years with average diversions about 5 percent above average.[65] During those two years, diversions exceed 1283 cfs only 17 days in 2000 and 23 days in 2012.[66] During the days when diversions exceeded 1283 cfs, they did so by an average of 32 cfs

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proposed at Site 3, plus 6% for 2013-2016 inflation, yields $165 per linear foot for 84 inch diameter pipe. 2000 feet x $165/foot = $330,000.

[62] Appendix B, pdf p. 84 of 173.

[63] See the attached spreadsheet, "Multiple Pump costs" tab, line 2.

[64] This ignores the possibility of two different pumps failing at the same time, which is presumably very unlikely (since the DEIS did not propose having two backup pumps at each site).

[65] Diversions in those two years averaged 1094 cfs and 1097 cfs respectively. Appendix A, pdf p. 205 of 527. The average diversion for the most recent 11 years of available data was 1044 cfs (for the total 42 years of available data, the average diversion was 985 cfs). See the attached spreadsheet, "Historical diversions" tab, Excel cells F347 and F345. 1097 is 53 more than 1044, or 5%.

[66] Appendix A, pdf pp. 472-474 and 478-480 of 527.

in 2000 and 56 cfs in 2012.[67] Thus, averaged across the entire irrigation season, the average diversion in excess of 1283 cfs was just 6 cfs.[68]

The average number of days when a pump outage would affect diversion capability with 2000 or 2012 diversion rates is 20 per year.[69] The chance that there would be a pump out of service in all 20 such days is clearly much less than 100 percent. The consequences if there **were** a pump out of service on all 20 such days per year would be an average reduction in water deliveries of 6 cfs, or less than 0.6 percent of the annual average deliveries in 2000 and 2012 of about 1100 cfs.[70]

Spending millions of dollars to mitigate a small chance of a 0.6% impact is clearly not cost-effective. By not installing backup pumps at each site, but instead relying on the not-in-use pumps at other sites to provide backup, the capital cost of the Multiple Pump Scenario can be reduced by $2.163 million.[71] Because the Multiple Pump Scenario includes an additional 38.1% contingency for pump station costs,[72] the reduction in the total DEIS cost for pump stations will be $2.163 million x 138.1% = $2.987 million.[73] In addition, annual levelized operation, maintenance and replacement costs of $178,000 per year will be avoided.[74]

b. Back-up diesel generators at all five sites (as protection against power failures) - $3.446 million of capital cost

The DEIS includes capital costs of $2.495 million for diesel generators to provide a backup source of electricity in the event of a power failure.[75] This is an even more extreme case of overbuilding. Reliability data is publicly available for the Glendive district of Montana-Dakota Utilities (MDU). It shows that for the last 7 years, 2009-15

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[67] Ibid.
[68] (32*17 + 56*23)/(2*153) = 5.98.
[69] Ibid.
[70] Appendix A, pdf p. 205 of 527.
[71] Appendix B, pdf p. 119 of 173. This is just the cost for the back-up pumps themselves, and does not include the cost savings for any reduction in building size and installation costs, which could be considerable.
[72] Appendix B, pdf p. 84 of 173.
[73] See the attached spreadsheet, “Multiple Pump costs” tab, line 3.
[74] Appendix B, pdf p. 171 of 173, 25% (one pump out of four proposed at each site) times OM&R categories 11-14 and 16 costs of $713,000 per year.
[75] Appendix B, pdf p. 115 of 173.

inclusive, the average customer has experienced 222 minutes per year of outages,[76] or 3.7 hours per year. That's less than one hour in 2000. The longest single outage during that entire period appears to be an outage lasting 11 hours on July 27 of 2015.[77] The **expected** consequences of not having backup generators would thus be 3.7 outage hours per 8760 (the number of hours in a year) x 153 days out of 365 (because outages outside the irrigation season would not affect pumping, and pumping would not be required in April) x .73 (because 27 percent of the time during the irrigation season no pumping would be happening)[78] x 459 cfs (the average pumping rate while pumping),[79] or less than 0.1 cfs on average.

Or consider the worst case situation, an 11 hour long outage that affected all five pump stations and occurred on a day when all 5 pump stations were in use. That's what the July 27, 2015 outage would have been if the Multiple Pumps alternative had been in effect then (and **if** the outage had affected all five pump sites). Diversions that day averaged 1310 cfs, so shutting off power for 11 hours would have reduced average diversions that day by 11/24 x 1310 = 600 cfs. Diversions on the following days were 1280-1310 cfs. By increasing them to 1374 cfs for the next 9 days, the entire shortfall on July 27 would have been replaced. Farmers would have received at most 46 percent less water than they expected, for one day only, but then 5-7 percent more on each of the next 9 days. It's hard to imagine the consequences of such a once-in-a-decade event merit spending millions on backup generators. According to the DEIS, the capital cost for the five proposed back-up generators is $2.495 million.[80] Because the Multiple Pump Scenario includes an additional 38.1% contingency for pump station costs,[81] the reduction in the total DEIS cost for pump stations will be $2.495 million x 138.1% = $3.446 million.[82]

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[76] Data for the 2005-08 period shows an outage rate less than half as large as for 2009-15. For the last seven years, outage rates have been fairly flat, with no up or down trend.
[77] 2015 MDU Electric Reliability Report, available at http://www.psc.mt.gov/docs/ElectricReliabilityReports/2015ElectricReliabilityReports/default.asp.
[78] Appendix A, pdf p. 205 of 527.
[79] Ibid.
[80] Appendix B, pdf p. 115 of 173.
[81] Appendix B, pdf p. 84 of 173.
[82] See the attached spreadsheet, "Multiple Pump costs" tab, line 4.

5. Reduced capital cost for lower adaptive management costs

The DEIS assumes that whatever construction costs are forecasted to be incurred have to be increased by one percent to account for adaptive management during construction.[83] Thus when capital costs are reduced, as described above, the DEIS's cost methodology would reduce annualized adaptive management costs by a further one percent. That reduction comes to $74,000.[84]

6. Reduced direct capital costs from shortened pipe lengths also reduce associated planning, engineering, design and construction management costs - $1.038 million

The excess direct capital costs in the DEIS estimate for the Multiple Pump alternative which are identified above (before contingency adders) come to $5.471 million.[85] The DEIS calculates additional costs for planning, engineering, design, and project management equal to 15 percent of the direct capital costs.[86] Thus, reducing direct capital costs by $5.471 million would, according to the DEIS, reduce the associated planning, engineering, design, and construction management costs $5.471 x 0.15 = $0.821 million.

The DEIS includes a 26.52 percent contingency factor for planning, engineering, design, and construction management costs for the Multiple Pump Alternative.[87] Thus the

[83] DEIS, p. 2-98. Also Appendix B, pdf p. 22 of 173 (making clear that the 1 percent is for adaptive management "during construction").
[84] See the attached spreadsheet, "Multiple Pump costs" tab, line 5.
[85] $0.429 million for reduced discharge pipe length for site 3, $0.330 million for reduced discharge pipe length for sites 4-5, $2.163 million for eliminating back-up pumps, $2.495 million for eliminating back-up generators, and $0.054 million for adaptive management during construction. See the attached spreadsheet, "Multiple Pump costs" tab, lines 1-5, "Direct cost adjustment" column.
[86] Appendix B, pdf pp. 12-13 of 173. Note that the actual planning, engineering, design, and construction management costs shown in the DEIS are $12.772 million for a construction contract of $84.277 million (Appendix B, pdf p. 84 of 173), which is 15.15 percent and not 15%. The apparent reason for the extra 0.15% is the 1 percent adder for adaptive management costs during construction (DEIS, p. 2-98). Those costs are not shown on the page cited here but their impact on planning, engineering, design, and construction management costs **is** included.
[87] Appendix B, pdf p. 84 of 173.

total cost reduction for planning, engineering, design, and construction management costs would be $0.821 million x 1.2652 = $1.038 million.[88]

7. Reduced investment costs due to reduced interest during construction - $0.425 million

The DEIS estimates that the direct ("first") cost of the Multiple Pumps alternative, $132.028 million,[89] would be increased by another $6.557 million, or 4.966 percent, due to interest during construction.[90] The adjustments described above reduce the cost of the Multiple Pump alternative by $8.551 million.[91] Thus they would also reduce the interest during construction by $8.551 million x 4.966 percent, or $425,000.[92]

8. Adjusted capital cost is lower by $8.975 million, which corresponds to 6.476 percent, which corresponds to $0.339 million per year on an annualized basis.

The total of the adjustments described above, including reduced interest during construction, comes to $8.975 million.[93] That is 6.476 percent of the total investment cost of $138.585 million reported in the DEIS.[94] The DEIS then calculates that the levelized average **annual** investment cost associated with an investment cost of $138.585 million will be $5.515 million, for a fixed charge rate of 3.98 percent.[95] The corresponding reduction in annual investment-related costs, based on the 6.476 percent adjustment identified above, will be 6.476 percent x $5.515 million, or $357,000 per year.

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[88] See the attached spreadsheet, "Multiple Pump costs" tab, line 6.
[89] Ibid.; also DEIS, p. xxxii, Table ES-1.
[90] DEIS, p. xxxii, Table ES-1.
[91] $0.568 million for reduced discharge pipe length for site 3, $0.437 million for reduced discharge pipe length for sites 4-5, $2.987 million for eliminating back-up pumps, $3.446 million for eliminating back-up generators, $0.074 million for adaptive management during construction, and $1.038 million for planning, engineering, design, and construction management costs. See the attached spreadsheet, "Multiple Pump costs" tab, line 12.
[92] See the attached spreadsheet, "Multiple Pump costs" tab, line 7.
[93] See the attached spreadsheet, "Multiple Pump costs" tab, line 8.
[94] DEIS, p. xxxii. 8.975/138.585 = .06476 = 6.476%.
[95] Ibid. 5.515/138.585 = .039795 = 3.98%. See also the attached spreadsheet, "Multiple Pump cost" tab, line 12.

Alternatively, the reduction can be calculated as $8.975 million x 3.98 percent, which is also $357,000 per year.[96]

9. Corrected annualized cost is $9.949 million per year

The DEIS reports a total annualized cost for the Multiple Pumps Alternative of $10.595 million per year.[97] The adjustments described above reduce that number by $0.646 million, based on reductions of $289,000 per year for electricity operating costs and pump OM&R,[98] and $357,000 per year for annualized capital cost savings.[99] The adjusted annualized cost for the Multiple Pumps Alternative is thus $9.949 million per year.[100]

10. Environmental benefits to sturgeon

The DEIS presents calculated Habitat Unit (HU) values for each Alternative, and the increase over the No Action Alternative that each other alternative would produce.[101] As discussed above (Section III.C) the DEIS numbers are basically meaningless, because they average sturgeon HU values together with HU values for 13 other species, including such non-threatened species as smallmouth bass.[102] The DEIS nowhere provides sturgeon-specific HU values. However, this shortcoming is easily overcome, since the DEIS does provide the equations and the data needed to calculate the sturgeon-specific HU for each alternative.[103] Using the data in the DEIS, the pallid sturgeon-specific fish passage connectivity indices (FPCI) are .0252 for the No Action Alternative,[104] 0.600 for the Bypass Channel Alternative,[105] and 1.000 for the Multiple Pumps Alternative.[106]

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[96] See the attached spreadsheet, "Multiple Pump costs" tab, line 13.
[97] DEIS, p. xxxii.
[98] See the attached spreadsheet, "Multiple Pump costs" tab, line 14.
[99] See the attached spreadsheet, "Multiple Pump costs" tab, line 13.
[100] See the attached spreadsheet, "Multiple Pump costs" tab, line 17.
[101] Appendix D, p. 16.
[102] Appendix D, pp. 4, 9, 14, 15.
[103] Appendix D, pp. 2, 10 (formulae underlying FPCI), 4 (habitat acres), 11-12 and 14-15 (data used in the FPCI formula. HU is then simply FPCI x habitat acres.
[104] [(5 + 2)/2]*1*.018 / 25 = .252; see Appendix D, pp. 11-12, 14-15 for data.
[105] [(2 + 4)/2]*5*1 / 25 = 0.600; ibid.

Note that the FPCI for the Bypass Channel Alternative, is 20 percent higher than the corresponding FPCI for that alternative in the 2015 Supplemental EA. In that document, the value for the Fl parameter was given as 3,[107] but in the DEIS it has been increased to 4.[108] The DEIS neither acknowledges nor explains this increase.

Multiplying the alternative-specific sturgeon FPCIs times the 12637 acres of pallid sturgeon habitat upstream of Intake Dam[109] gives the following sturgeon-specific HUs: 318 for the No Action Alternative, 7582 for the Bypass Channel Alternative, and 12,637 for the Multiple Pump Alternative.[110] The incremental HUs are then 7264 when going from No Action to Bypass, 12,319 when going from No Action to Multiple Pumps, and 5,055 when going from Bypass Channel Alternative to the Multiple Pump Alternative.[111]

V. Implications of the DEIS cost/benefit methodology with adjusted Multiple Pumps Alternative costs

The DEIS's cost/benefit methodology is based on choosing the alternative with the lowest cost per added AAHU, as compared to the AAHU with the No Action Alternative. The numbers in the DEIS clearly indicate that the Multiple Pumps Alternative is better for pallid sturgeon than the Bypass Channel Alternative, by a margin of 5055 sturgeon HUs.[112] The problem with the Multiple Pumps Alternative, according to the DEIS methodology, is not even that it costs too much. The DEIS calculates costs of $727/AAHU for the Bypass Channel Alternative and $962/AAHU for the Multiple Pump

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[106] [(5 + 5)/2] *5 *1 / 25 = 1.000; ibid. Note that the value on p. 12 in Table 1-8 is shown as 2, but this is a typo and it should be 5. The DEIS does not show the actual FPCI calculations, but it appears they used 5, as they should have.
[107] Supplemental EA, Appendix E, Attachment 1, "Fish Passage Benefits Analysis," p. 16, Table 6.
[108] Appendix D, p. 11, Table 1-7.
[109] Appendix D, p. 4, Table 1-1, last line.
[110] See the attached spreadsheet, "Costs per AAHU" tab.
[111] Ibid.
[112] Ibid, line 3. Even when 13 species other than sturgeon are considered, the DEIS concludes that the Multiple Pump Alternative is better than the Bypass Channel Alternative, by a margin of 3895 HUs. Appendix D, p. 22, Table 2-5.

Alternative, and concludes that both of those alternatives are cost-effective.[113] The adjusted costs discussed above, and the use of sturgeon-specific HUs, narrow the gap between the Bypass Channel and Multiple Pump Alternatives considerably, to $724/sturgeon AAHU for the Bypass Channel Alternative and $808/sturgeon AAHU for the Multiple Pumps with the adjustments above.[114] Applying the 2015 EA FPCI scores results in a cost of $876/sturgeon AAHU for the Bypass Channel Alternative[115] – substantially higher than the DEIS estimates, and higher than the Multiple Pumps Alternative.[116] As noted above, the cost/sturgeon AAHU may be as high as $1,110 if uncertainty of the fish passage benefit is included in the calculation.[117] Again, the failure of the agencies to incorporate uncertainty into their analysis completely reverses the conclusions regarding the cost effectiveness of their preferred alternative.[118]

VI. Alternative approaches – additional overpricing of the multiple pumps alternative

The Agencies have emphasized costs as a determining factor for preference in comparing one alternative against the rest (as opposed to efficiency or effectiveness). In addition, the Multiple Pumps Alternative evaluated in the DEIS is designed to ensure that the irrigation district receives even more water than it is guaranteed to receive now, and the agencies never consider the many ways that the costs could be reduced and irrigation water delivered through alternative mechanisms. Therefore, it is appropriate to question why they did not address a other mechanisms that reduced overall costs while maintaining high probabilities of fish passage. Additional avenues of cost savings not analyzed by the Agencies in the Multiple Pumps Alternative are listed below. There are multiple configurations that the Agencies failed to analyze.

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[113] Appendix D, p. 20, Table 2-3. Note that the DEIS uses costs that do not have any of the adjustments discussed above, and uses HU values for 14 total species, of which pallid sturgeon is just one.
[114] See the attached spreadsheet, "Costs per AAHU" tab, lines 2 and 3.
[115] See the attached spreadsheet, "Costs per AAHU" tab, line 2a.
[116] Ibid., lines 2a and 3.
[117] Ibid., line 2b.
[118] Ibid., lines 2-2b versus lines 3-4.

For example, using three pump sites instead of the five in the Multiple Pumps Alternative, which was not considered or analyzed in the DEIS, could provide 100 percent of the sturgeon passage benefits of the Multiple Pump alternative, and on average allow 96 percent of the historical level of water diversion rights, at only 75-80 percent of the cost.[119] Using only three pump sites would have a 10.4 percent lower cost per unit of sturgeon habitat improvement than any alternative considered in the DEIS,[120] and a quantity of habitat improvement equal to the highest level of any alternative considered in the DEIS. It would also allow the irrigators to divert their actual historical average annual diversions 99 percent of the time.[121] Thus, using fewer pumps than analyzed in the DEIS, Multiple Pumps Alternative would be much better for pallid sturgeon than the DEIS-endorsed Bypass Channel Alternative, and not nearly as bad for farmers as the Bypass Channel Alternative would be for sturgeon (when compared to using multiple pumps).

Adding the most cost-effective of the measures from the Multiple Pumps with Conservation Measures Alternative, combined with using fewer pumps, would make the Multiple Pumps Alternative even better at meeting the water needs of farmers (section VII.A). Acknowledging the existing trend of conversion from flood irrigation to sprinklers would further reduce the impact on farmers (section VII.B). Additional options could also reduce the impact on farmers from an alternative where pumping with fewer sites could not produce the entire water right (sections VII.C-E).

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[119] Per section VI.B, below, and the attached spreadsheet, “Three Pump Sites cost” tab, line 23, using three pump sites instead of five would have an annualized cost of $7.985 million. Per the DEIS, the Multiple Pumps Alternative would have an annualized cost of $10.595 million. Per section IV.B, below, and the attached spreadsheet, that cost could be lowered to $9.949 million. $7.985/$10.595 = .754 = 75.4%. $7.985/$9.949 = .803 = 80.3%.

[120] $648 per annual average HU, versus $724 (and possibly as much as $1,110) for the Bypass Channel Alternative. See the attached spreadsheet, “Cost per AAHU” tab, lines 2-2b and 4. 648/724 = .896, or a 10.4% reduction.

[121] Actual diversions average only about ¾ of diversion rights, so an alternative that provides less than 100 percent of diversion rights will provide a higher percentage of diversion needs than of diversion rights. Over a 42 year period for which data is available, diversions have averaged 985 cfs, which is only 72% of 1374 cfs (attached spreadsheet, “Historical diversions” tab). Even the average diversion over the 11 years since 2003 for which data is available, 1045 cfs (ibid.), is only 76% of 1374 cfs. The DEIS assumes an average diversion of 1100 cfs (Appendix A, pdf p. 204 of 527; that is above the historical average), but even that is just 80 percent of 1374 cfs. The attached spreadsheet, “Flows with no dam, 3 pump sites” tab, Excel cells A32 (99 percent exceedance line) and BG32 (1047 cfs diversion feasible at that exceedance level) shows that using three pump sites could divert more than 1045 cfs 99 percent of the time.

A. Pump sites 1-2 result in high costs for small additional water diversions; savings from omitting sites 1-2

In the Multiple Pumps Alternative, the number of pumps and pump stations was chosen so as to assure potential diversions of 1374 cfs in every hour of every year, without regard to hydrological conditions. That is actually somewhat more diversion capacity than currently exists, since the current diversion right of 1374 cfs is contingent on river flows above 3000 cfs at Intake,[122] which 42 years of irrigation-season gauge data shows fails to happen 0.68 percent of the time (2.92% of the time in August).[123] So times already currently exist where the full 1374 cfs cannot be legally withdrawn.

The DEIS also shows that gravity diversions of at least 167 cfs would be possible at all times even with the Intake Dam removed (or 207 cfs if periods when the Yellowstone River flow is below 3000 cfs are excluded, since at those times diversions would not be allowed even if the Intake Dam were present).[124] However, making those gravity diversions would not be possible if pumping were occurring at pump sites 1 or 2, the two sites closest to Intake. Thus, in order to pump more than 825 cfs (the amount that could be pumped from sites 3-5), gravity diversions would have to cease. The result is that the 550 cfs that could be pumped from sites 1-2 would come at the price of a reduction of at least 167-207 cfs in gravity diversions. Hence, the net increase in possible diversions due to the inclusion of sites 1 and 2 in the Multiple Pumps Alternative is, at most, 525 minus 167-207 cfs, or 318-358 cfs.

The DEIS also shows that pump sites 1-2 would be expected to be needed to operate only 3 percent of the time.[125] Given that very low capacity factor one may ask, what happens if Pump Sites 1 and 2 are not developed? Farmers would receive somewhat

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[122] Appendix A, pdf pp. 352-353 of 527.

[123] Based on 1967-2008 daily Sydney gauge flows on May-September days at or below 1620 cfs, which implies that even if Intake diversions had been the maximum 1374 cfs, with no return flows between Intake and Sydney, Intake flows would have had to be no more than 2994 cfs. See the attached spreadsheet, "Sydney gauge data" tab, Excel cells F11 – I22. Note that the DEIS assumes no return flows in at least the first 18.7 river miles below Intake. Appendix A, pdf p. 194 of 527.

[124] See the attached spreadsheet, "Flows with no dam, 5 pump sites" tab, Excel column R and the note below in columns Q-U.

[125] Appendix B, pdf p. 197 of 527.

less water, which would theoretically affect crop yields and revenues (a cost to them). But on the other hand, they would lower operating costs to pay, which would be a benefit to them. The discussion below addresses both the cost savings from building fewer pumps, and the water diversion and delivery implications of doing so by using only three pump sites (3-5 in the DEIS's Multiple Pumps Alternative).

The analysis below does not answer the question of whether farmers would be better served by using three pump sites (lower cost, less water) or a Multiple Pump Alternative (higher cost, more water). Nor does it answer the threshold standard set in the DEIS, that any alternative selected for development should be "sustainable."

B Effects of Using only Three Pump Sites

1. Consequences for sturgeon

Using only three pump sites would look much like the Multiple Pumps Alternative in the DEIS, but without development of pump sites 1 and 2. Because it would also remove the existing Intake Dam, its fish passage effects would be the same as those of the other no-weir alternatives. It would produce 12,319 incremental HUs for sturgeon, relative to the No Action Alternative.[126] That is some 5055 HUs (70 percent) more than the increase of 7,264 sturgeon HUs produced when going from the No Action Alternative to the Bypass Channel Alternative.[127]

2. Consequences for farmers[128]

Because it would never pump water into the Main Canal above the Burns Creek Overchute, using three pump sites would allow for simultaneous pumping and gravity diversions in all hours. However, it would not be able to divert 1374 cfs in as many hours.

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[126] Section V.B, above. See also the attached spreadsheet, "Cost per AAHU" tab.
[127] Ibid.
[128] All numerical results in this subsection are based on DEIS hydrology data from Appendix A, pdf p. 197 of 527, and on annual diversion data for 42 years and monthly diversion data for 28 years, all supplied by the Agencies in various data responses to Defenders of Wildlife and NRDC. All of the data and calculations from the data not footnoted below are shown in the attached spreadsheet, in the "Flow with no dam, 3 pump sites" tab.

The Bypass Channel Alternative would allow diversions of 1374 cfs in about 98.6 percent of all hours,[129] but would produce only 7264/12319 = 59% as many incremental sturgeon HUs as a no-weir alternative.[130] Conversely, using three pump sites would produce the maximum level of incremental sturgeon HUs, but would allow diversion of 1374 cfs only 68 percent of the time.[131] It would, however, allow average diversions **above** the historical average monthly diversion in the months of May, June, and September, and under 97% of hydrological conditions in July and 70+ percent in August.[132] Even when feasible diversions did not reach 1374 cfs, they would exceed 1100 cfs 97% of the time.[133] 1100 cfs is more than the historical average monthly and annual diversions that have actually occurred at Intake.[134] The expected average annual diversion, taking into account monthly diversion requirements that are well below 1374 cfs, would be 1140 cfs, or 346,000 acre-feet.[135] That is 9.1 percent above the average annual diversion over the last 11 years of 317,000 acre-feet.[136] The expected **feasible** average annual diversion using three pump sites would be 1324 cfs, or over 400,000 acre-feet for the May-September season.[137] 1324 cfs is over 96 percent of the maximum

[129] Based on the current 1374 cfs diversion right requiring Yellowstone River flows at Intake of 3000 cfs and above, per Appendix A, pp. 352-3. Interpolated between 98 and 99 percent per data in Appendix A, pdf p. 328 of 527.
[130] See analysis above, and in the attached spreadsheet, "Costs per AAHU" tab.
[131] Appendix A, pdf p. 322 of 527. The 68% figure is the percentage of the time that gravity diversions would be above 549 cfs, which when combined with up to 825 cfs of pumping from three sites would allow total diversions of 1374 cfs. The 68% figure can also be interpolated from Appendix A, pdf p. 197 of 527, showing gravity diversions of 527 cfs as feasible 70% of the time and diversions of 620 cfs as feasible 60% of the time.
[132] Attached spreadsheet, "Flows with no dam, 3 pump sites" tab. Excel cells V7-Z7 show the historical average monthly diversions, based on 28 years of data from the "Historical diversions" tab, Excel cells F337-F341, and scaled up 9% to reflect annual diversions in the most recent 11 years ("Historical diversions tab", Excel cell F347) which were higher than those in the 28 years with monthly data (Historical diversions" tab, Excel cell F342). The percent of the time 825 cfs could meet average monthly pumping diversions is determined by looking at the cell in columns V-Z where the required pumping exceeds 825 cfs, and reading across to the corresponding exceedance level in Column A.
[133] Appendix A, pdf pp. 204-205, showing only pump sites 3-5 are needed 97 percent of the time to achieve 1100 cfs of total diversion. The 97 percent figure can also be interpolated from the 95% and 98% lines on Appendix B, pp. 197 or 329, showing that gravity diversions of 275 cfs will be achievable 97% of the time. 275 cfs of gravity diversion, when combined with 825 cfs of pumping from three sites, produces a total diversion of 1100 cfs. See also the attached spreadsheet, "Flows with no dam, 3 pump sites" tab, rightmost column (showing pumping capacity at different gravity diversion exceedance levels) and the leftmost column (showing the exceedance levels for each line of data). For exceedance levels up to 97 percent in the leftmost column, potential diversions in the rightmost column exceed 1100 cfs.
[134] See the attached spreadsheet, "Historical diversions" tab, Excel cells F337-347.
[135] See the attached spreadsheet, , "Flows with no dam, 3 pump sites" tab, Excel cells BE40 and BE41.
[136] Ibid., Excel cells BE43 and BK43.
[137] Ibid., Excel cells BG40 and BI40.

diversion of 1374 cfs under the current water right.[138] Thus, though the Agencies did not analyze daily demand with actual hydrology, it is likely that irrigators would get most of the water they need most of the days they need it.

C. Costs using only three pump sites

The only reason to choose three pump sites instead of five is cost. Since the DEIS puts a premium on cost in choosing between alternatives, the cost benefits of the using just three pump sites would be significant if the ultimate decision is based on the logic of the DEIS.

Using fewer pump sites would have substantially lower capital **and** operating costs for any Multiple Pumps Alternative. The cost estimates below are based on the data supplied in the DEIS.

1. Capital costs

The DEIS shows a total capital cost for the Multiple Pumps Alternative of $132.028 million.[139] This cost is broken down in the DEIS Appendices into land, construction, planning/engineering/design, and construction management components, as well as contingency adders for each of those components.[140] The discussion below quantifies the savings from each of these components using three pump sites as compared to the Multiple Pumps Alternative.

a. Land - $0.222 million

The DEIS forecasts land acquisition costs of $443,000, or $554,000 when contingency costs are included.[141] With three pump sites instead of five, those costs could be reduced by 40 percent, or a total of $222,000.[142]

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[138] 1324/1374 = .963 = 96.3%.
[139] DEIS, p. xxxii, Table ES-1. Also p. 2-99, and Appendix B, pdf p. 84 of 173.
[140] Appendix B, pdf p. 84 of 173.
[141] Ibid.

b. Construction - $31.524 million

The DEIS forecasts construction contract costs of $84.277 million before contingency.[143] It then disaggregates the forecasted construction contract cost by site, with the forecasted costs for Sites 1 and 2 equal to $10.484 million and $12.561 million, respectively, or a total of $23.044 million.[144] The DEIS applies a contingency rate of 36.8 percent to its construction estimate,[145] which means the $23.044 million savings have to be increased by 36.8 percent, to $31.524 million.[146]

c. Reduced piping length for sites 3-5 discharge pipes - $1.005 million

As described above in the discussion of the Multiple Pumps Alternative, the DEIS chooses routes for the discharge pipes for sites 3-5 which are inordinately long. Alternate routes would save piping costs estimated to be at least $1.005 million.[147] There would be additional capital cost savings for reduced installation costs, which are not quantified here due to lack of data in the DEIS.

d. Reduced costs associated with backup pumps - $0

In the discussion above of the Multiple Pump Alternative, backup pumps are identified as an unnecessary expense, since with 15 pumps at five different sites, there will be very few hours when all 15 pumps will need to be in service. Thus, pump outages can be mitigated by using one of the other 14 pumps. If only three pump sites are used, there would be only nine pumps, and they would be much more likely to all be in service

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[142] See attached spreadsheet, "Three Pump Sites cost" tab, line 1.
[143] Appendix B, pdf p. 84 of 173.
[144] Appendix B, pdf p. 157 of 173.
[145] Appendix B, pdf p. 84 of 173.
[146] See attached spreadsheet, "Three Pump Sites cost" tab, line 2.
[147] See section V.B, above. The $1.005 million consists of $0.429 million of direct costs and $0.139 million of contingency at Site 3, and $0.330 million of direct costs plus $0.107 million of contingency at Sites 4-5. See also the attached spreadsheet, "Three Pump Sites cost" tab, lines 3-4.

at any given time.[148] Thus if only three pump sites are used, a backup pump may be reasonable at each site.

e. Reduced cost associated with backup generators - $2.666 million

The analysis of the Multiple Pump Alternative, above, quantified a capital cost savings of $3.446 million from not installing backup generators at each site. The basis for forgoing backup generation is the infrequency of power failures, coupled with their short duration, as discussed above. The same logic applies at fewer pump sites.[149] However, $0.780 million of the savings associated with not having backup generators at sites 1 and 2 was already counted above as part of the construction cost savings.[150] The additional capital cost savings for not installing back-up generators at sites 3-5 would thus be $2.666 million.[151]

f. Adaptive management - $0.354 million

The DEIS adds 1 percent to the construction costs of each alternative for adaptive management costs during construction.[152] Thus, by the logic of the DEIS, the cost savings identified above would also reduce the associated adaptive management costs if there were fewer pump sites. The direct cost savings identified above are $25.905 million,[153] or

[148] Based on historical average August diversions and DEIS hydrological data on gravity diversion exceedance rates, in August all nine pumps would need to operate 40% of the time. See attached spreadsheet, “Flows with no dam, 3 pump sites” tab, Excel cells A23 (showing the 60 percent exceedance line) and AU23 (showing this is the highest exceedance level at which only 8 pumps would need to be on).
[149] See the attached spreadsheet, “Three Pump Sites cost” tab, line 6.
[150] $0.570 million for back-up generators at sites 1 and 2 (Appendix B, pdf p. 115 of 173, plus 36.8% for the contingency associated above with construction costs (Appendix B, pdf p. 84 of 173), for a total of $0.780 million. See also the attached spreadsheet, “Three Pump Sites cost” tab, line 7.
[151] $3.446 million savings from having no back-up generators, minus $0.780 million already counted for Sites 1-2. The direct savings at sites 3-5, before contingency, would be $1.925 million (Appendix B, pdf p. 115 of 173). See also the attached spreadsheet, “Three Pump Sites cost” tab, lines 6-7.
[152] DEIS, p. 2-98. Also Appendix B, pdf p. 22 of 173.
[153] $0.177 million for land, $23.044 million for construction, $0.759 million for shorter discharge pipes at sites 3-5, and $1.925 million for eliminating back-up generators at sites 3-5. See also the attached spreadsheet, “Three Pump Sites cost” tab, lines 1-7, “Direct cost adjustment” column.

$35.417 million including contingency.[154] The associated reduction in adaptive management costs, by the logic of the DEIS, would be one percent of that, or $0.259 million directly and $0.354 million including contingency.[155]

g. Planning, engineering, design, and construction management - $4.965 million

The DEIS calculates additional direct costs for planning, engineering, design, and project management equal to 15 percent of the direct capital costs.[156] The direct costs identified above are $26.164 million.[157] Fifteen percent of that would be $3.925 million.[158] In addition, the DEIS associates 26.52% contingency with planning, engineering, design, and project management costs.[159] So the total savings in planning, engineering, design, and project management costs for only three pump sites would be $3.925 million times 1.2652 = $4.965 million.[160]

h. Interest during construction - $3.318 million

Using only three pump sites would reduce interest during construction two different ways. First, since construction costs would be lower, the interest on them would be lower. The total cost savings identified above are $40.737 million,[161] which is 30.85

[154] $0.222 million for land, $31.524 million for construction, $1.005 million for shorter discharge pipes at sites 3-5, and $2.666 million for eliminating back-up generators at sites 3-5. See also the attached spreadsheet, “Three Pump Sites cost” tab, lines 1-7, “Total cost adjustment” column.
[155] See the attached spreadsheet, “Three Pump Sites cost” tab, line 8.
[156] Appendix B, pdf pp. 12-13 of 173.
[157] $0.177 million for land, $23.044 million for construction, $0.759 million for shorter discharge pipes at sites 3-5, $1.925 million for eliminating back-up generators at sites 3-5, and $0.259 million for associated adaptive management. See also the attached spreadsheet, “Three Pump Sites cost” tab, lines 1-8, “Direct cost adjustment” column.
[158] See the attached spreadsheet, “Three Pump Sites cost” tab, line 9.
[159] Appendix B, pdf p. 84 of 173, lines 13-14.
[160] See the attached spreadsheet, “Three Pump Sites cost” tab, line 9.
[161] $0.222 million for land, $31.524 million for construction, $1.005 million for shorter discharge pipes at sites 3-5, $2.666 million for eliminating back-up generators at sites 3-5, $0.354 million for adaptive management during construction, and $4.965 million for reduced planning, engineering, design, and project management costs. See also the attached spreadsheet, “Three Pump Sites cost” tab, lines 1-9, “Total cost adjustment” column.

percent[162] of the DEIS-estimated $132.028 million total first cost[163] of the Multiple Pump Alternative. Thus, the $6.557 million interest cost shown in the DEIS for the Multiple Pump Alternative[164] could be reduced by 30.85%, a reduction of $2.023 million,[165] to $4.534 million.

Second, because of the smaller scope of the Alternative, it could be built more quickly than the Multiple Pumps Alternative. The DEIS estimates a 42-month construction period for the Multiple Pumps Alternative, with staggered construction of at the five pump sites.[166] Based on the DEIS's own schedule, eliminating two pump sites would shorten the construction period by one year, to 30 months.[167] Thus the interest during construction would be at least 12/42, or 28.6 percent[168] less. That would lower the $4.534 million in interest costs associated with a smaller project by a further $1.295 million.[169]

The total reduction in interest during construction would be $2.023 million plus $1.295 million, or $3.318 million.

2. Annualized capital costs reduction for reduction in pump sites - $1.702 million

The total of all the construction cost adjustments identified above for reducing pump sites comes to $42.760 million.[170] That is 30.85 percent of the total investment cost of $138.585 million reported in the DEIS.[171] The DEIS then calculates that the levelized average **annual** investment cost associated with an investment cost of $138.585 million will be $5.515 million.[172] The corresponding reduction in annual investment-related costs,

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[162] $40.737/$132.028 = .30855 = 30.855%.
[163] DEIS, p. 2-99, table 2-26.
[164] Ibid.
[165] See the attached spreadsheet, "Three Pump Sites cost" tab, line 10.
[166] DEIS, p. 2-99, table 2-26.
[167] Appendix B, pdf p. 50 of 173, lines 64-66.
[168] 12/42 = .286 = 28.6%.
[169] See the attached spreadsheet, "Three Pump Sites cost" tab, line 11.
[170] See the attached spreadsheet, "Three Pump Sites cost" tab, line 12.
[171] DEIS, p. xxxii and 2-99. $42.76/$138.585 = .30854 = 30.85%.
[172] Ibid.

based on the 30.85 percent adjustment identified above, will be 30.85 percent x $5.515 million, or $1,702,000 per year.[173]

3. OM&R cost reductions - $909,000 per year

The OM&R costs for the Multiple Pumps Alternative, which represent over half of its total costs, are summarized on a single page of the DEIS.[174] They are divided into 30 categories, some 18 of which would be less expensive with three pump sites instead of the five pump sites in the Multiple Pumps Alternative. Specific adjustments are summarized below.

a. Costs that would be reduced proportionally to the number of sites - $583,000 per year

Most of the OM&R cost savings for reducing the number of pump sites come from the 40 percent reduction in the number of pump sites, and are proportional to that reduction. Cost items 11-19, and 21 are pump-related costs that would be reduced 40 percent. Cost items 23-25 and 27 are fish screen and trash rack costs that would also be reduced 40 percent, as would item 28, bank stabilization. The DEIS calculates annualized costs for each of these cost items.[175] A forty percent reduction would reduce the OM&R cost by a total of $583,000 per year.[176]

b. Power cost reductions - $139,000 per year

The DEIS estimates that annualized power costs would be $500,000 per year for 10,100 Mwh per year of pumping energy.[177] The attached spreadsheets show that pumping requirement would be reduced to 7296 Mwh, based on the monthly pattern of

173 See the attached spreadsheet, “Three Pump Sites cost” tab, line 19.
174 Appendix B, pdf p. 171 of 173.
175 Ibid.
176 Annualized cost reductions of $188K for item 11, $40K for item 12, $24K for item 13, $15K for item 14, $2K for item 15, $19K for item 16, $2K for item 17, $96K for item 18, $26K for item 19, $4K for item 21, $8K for item 23, $75K for item 24, $60K for item 25, $19K for item 27, and $5K for item 28.
177 Ibid. (item 20)

diversions, monthly Yellowstone River flow probabilities and associated gravity diversion capability, operating pump sites in economic order, and turning on pumps at each pump site individually as needed.[178] The resultant power costs would be only 7296/10100 of the $500,000 per year in the DEIS, or $361,000 per year, for a savings of $139,000 per year.[179]

c. Reduced feeder canal maintenance - $120,000 per year

Using three pump sites would eliminate two of the five feeder canals required by the Multiple Pumps Alternative. However, because the proposed feeder canals are of different lengths,[180] and because maintenance costs might be assumed proportional to the length of the feeder canals and not the number of canals, the savings might be less than 40 percent. However, that is not what the DEIS assumed. The DEIS assumes each feeder canal will have the same annual maintenance cost, $60,000.[181] Thus, based on the DEIS, a using three pump sites would save $120,000 per year in feeder canal maintenance costs.[182]

d. Reduced passage and entrainment monitoring - $67,000 per year

The DEIS estimates that annual costs to monitor fish passage and possible entrainment are currently $400,000 per year, which corresponds to an annualized cost over 50 years of $111,000 per year.[183] It then indicates that it expects those annualized costs to rise to $278,000 per year when entrainment monitoring costs at five pump stations are added in the Multiple Pumps Alternative.[184] Accepting the DEIS's numbers,

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[178] See the discussion above in section V.B regarding pumping energy as calculated in the DEIS. See also the attached spreadsheet, "Flows with no dam, 3 pump sites" tab, Excel cell BC40.
[179] See the attached spreadsheet, "Three Pump Sites cost" tab, line 13.
[180] Appendix A, pdf p. 209 of 527.
[181] Appendix B, pdf p. 171 of 173, cost item 26.
[182] See the attached spreadsheet, "Three Pump Sites cost" tab, line 15.
[183] Appendix B, pdf p. 163 of 173 (No Action Alternative), cost item 14.
[184] Appendix B, pdf p. 171 of 173, cost item 30.

using three pump sites would save 40 percent of the $167,000 per year increase for pump site monitoring, or $67,000 per year.[185]

4. Total annualized cost savings using three pump sites

The annualized cost savings identified above are $1.702 million associated with capital cost reductions, and $0.909 million associated with OM&R.[186] Thus the total annualized cost savings using three pump sites, as compared to the Multiple Pump Alternative, would be $2.610 million.[187]

5. Total annualized cost of using three pump sites

The DEIS quantifies the annualized cost of the Multiple Pump Alternative as $10.595 million. Reducing that by $2.610 million results in an annualized cost using three pump sites of $7.985 million.[188]

D. Cost-effectiveness of a using three pump sites

As described above, the total annualized cost of using three pump sites would be $7.985 million per year. Its benefits for pallid sturgeon would be the same as for the Multiple Pumps Alternative, some 12,319 sturgeon HUs more than the No Action Alternative and some 5,055 sturgeon HUs more than the Bypass Channel Alternative.[189] Thus using three pump sites instead of five would have a total cost of $648 per AAHU.[190] Using three pump sites instead of five would have an incremental cost for improving on the Bypass Channel Alternative of $540 per HU.[191] Since both its cost relative to the No

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[185] See the attached spreadsheet, "Three Pump Sites cost" tab, line 16.
[186] See the attached spreadsheet, "Three Pump Sites cost" tab, lines 19-20.
[187] See the attached spreadsheet, "Three Pump Sites cost" tab, line 21.
[188] See the attached spreadsheet, "Three Pump Sites cost" tab, line 23.
[189] See the attached spreadsheet, "Cost per AAHU" tab, line 4.
[190] $7.985 million / 12,319 sturgeon HU = $648/HU. See the attached spreadsheet, "Cost per AAHU" tab, line 4.
[191] $7.985 million annual cost for the using three pump sites; $5.256 million adjusted annual cost for the Bypass Channel Alternative; 5055 more HUs with using three pump sites than with the Bypass Channel

Action Alternative and its incremental cost relative to the Bypass Channel Alternative would be lower than the Bypass Channel Alternative's cost of $724-$1,110 per sturgeon HU,[192] using three pump sites instead of five would be superior to the Bypass Channel Alternative **using the DEIS's own methodology**.

VII. Further improvements with three pump sites

Unlike all of the alternatives considered feasible in the DEIS, reducing the number of pump sites would not always allow diversion of 1374 cfs.[193] Thus there would be some times when it would result in less water flowing to farms than under the other alternatives. However, there are ways to mitigate the resultant shortfalls that have already been identified in the DEIS. The DEIS analyzes several water conservation measures. It finds costs for most of them which, if accurate, mean they are more costly then simply installing and operating pumps, as described in the Multiple Pump Alternative. However, as described below, there are at least five measures that could be used to reduce the impact to farmers of reducing the number of pump sites.

Note that these are all measures to benefit farmers. None of them would do anything for sturgeon. Thus, to the extent each of these would increase the cost of the Multiple Pumps Alternative, it would increase the cost per sturgeon HU, and thus lower its cost-effectiveness as computed by the DEIS. They are included here only to illustrate ways in which the impact on water availability to farmers could be reduced if so desired.

A. Flow measurement devices

The irrigation system that currently exists lacks flow measurements at many locations. Failure to measure means overuse, whether accidental or intentional, cannot be

Alternative. ($7.985 million - $5.256 million)/5055 HUs = $2.729 million/5055 HUs = $540/HU. See the attached spreadsheet, "Cost per AAHU" tab, lines 2 and 4.

[192] See the attached spreadsheet, "Cost per AAHU" tab, lines 2-2b.

[193] The DEIS considers a Conservation Measures alternative which results in diversions less than 1374 cfs in many hours, which the DEIS rejects as both costly and infeasible. DEIS, pp. 2-97 (infeasible – fails to meet project purposes), 2-99 (costs more than double the cost of the next-most-expensive alternative, with no additional benefits to fish).

detected, nor can inefficient use. The DEIS identifies flow measurement device installation at 120 locations as a way to provide more data about how much water is being used in the irrigation system, where, and by whom.[194] The result will be expected changes in behavior that could reduce water use by 3 percent,[195] thereby reducing water diversions by an average of 31 cfs,[196] on average, at a capital cost of $1.301 million.[197] That's a capital cost of $42,000 per cfs.[198] Increased water diversion through adding pumps, when going from three pump sites to five, has a cost equivalent to a capital cost of $85,000 per cfs added.[199] Thus, adding flow measurement devices would appear to be cost-effective when compared to the cost of adding water deliverability through additional pump stations.

B. Sprinkler conversions

The DEIS estimates that sprinkler conversions on 5000 acres could save 62 cfs of water, while costing $19.28 million, for a capital cost of saved water of over $300,000 per cfs saved.[200] Increased water diversion through adding pumps, when going from three pump sites to five, has a cost equivalent to a capital cost of only $85,000 per cfs added.[201] Thus, according to the data in the DEIS, sprinkler conversions are not cost-effective as compared to additional pumping.

On the other hand, sprinkler conversions clearly are cost-effective under some conditions, as shown by the fact that they have been happening in the LYP. According to the DEIS, sprinkler-irrigated land has gone from about 5000 acres in 2009[202] to almost

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[194] Appendix A, pdf p. 360 of 527.

[195] Appendix A, pdf p. 393 of 527.

[196] Three percent based on a 2009 report cited in DEIS, with no subsequent analysis done for the DEIS (Appendix A, pdf p. 393 of 527). The one paragraph on pp. 419-420 of Appendix A contains no actual data. Note that these savings could include savings from reduced spill and reduced unneeded diversions from the Main Canal to laterals; they would not necessarily affect on-farm deliveries or usage at all. Average diversions of 1045 cfs (attached spreadsheet, "Historical diversions" tab, Excel cell F347) x 3% = 31.35 cfs.

[197] Appendix B, pdf p. 94 of 173, $1.133 million (line 14), plus planning, engineering, design, and construction management costs of 126.52% of 15% of $0.887 million.

[198] $1.301 million / 31 cfs = .04197 million/cfs.

[199] See the attached spreadsheet, "Cost for Pumping Capability" tab, rightmost column.

[200] $19.28 million / 62 = $0.311 million/cfs.

[201] See the attached spreadsheet, "Cost for Pumping Capability" tab, rightmost column.

[202] 9 percent of the irrigated acreage in 2009, per Appendix A, pdf p. 394 of 527. 9% x 55,000 acres = 4950 acres.

8000 acres currently,[203] an increase of about 3000 acres in just 7 years.[204] That is 60 percent of the amount of sprinkler conversions that DEIS finds uneconomic.[205] Clearly there are other reasons (increased efficiency, increased crop yields, reduced costs for managing on-farm irrigation, etc.) why farmers have converted to sprinklers. There is no reason to expect these reasons to cease in the future. To the extent using three pump sites instead of five increases the uncertainty of water supply, even slightly, it would further improve the economics of converting to sprinkler irrigation. Increased sprinkler conversions will reduce the amount of diversions called for by farmers, thus reducing the cost of operating with three pump sites, as sprinkler conversions continue into the future. Increased sprinkler conversions will also reduce the frequency of hours when farmers desire greater diversions than are feasible with just three pump sites.

C. Increased use of relift capability

The LYP currently has pump stations within its system that take water that would otherwise end up unused on farms, and "relift" it back to the canal system for irrigation use. According to the DEIS there are 4 such pump stations with a "relift" capability of 62 cfs.[206] The DEIS reports a current annual cost for pumping of $235,000 per year, which it assumes will continue into the future under all alternatives.[207] That's an annualized cost of $3,790 per cfs of pumping capability,[208] within one percent of the annualized cost of the DEIS's preferred Bypass Channel Alternative, $3,763-$3,825 per cfs.[209] So additional use of the existing 62 cfs of relift capability, and potentially adding additional relift capability, appears to be a cost-effective way to add water delivery capacity to the LYP without increasing diversions from the Yellowstone River,[210] and deal with hours when the pumping capacity would be unable to divert 1374 cfs from the Yellowstone River.

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[203] 7988 acres in 2016, per Appendix A, pdf p. 395 of 527.
[204] 7988 – 4950 = 3038 acres.
[205] 3000 / 5000 = 0.6 = 60%.
[206] Appendix A, pdf p. 421 of 527.
[207] Appendix B, pdf pp. 163, 165, 167, 169, 171, 173 of 173.
[208] $235,000/year / 62 cfs = $3,790/yr/cfs.
[209] $5.171 million (DEIS, p. xxxii, Table ES-1) / 1374 cfs = $3,763/cfs. $5.256 million (Section V.A, above) / 1374 cfs = $3,825/cfs.
[210] Of course, the fact that relift is already used in the LYP is also evidence of its cost-effectiveness.

D. Use of Pick-Sloan power for pumping energy

The energy pumping costs in the DEIS are based on commercial power prices, although the LYP correctly uses lower-cost energy from the Federal Pick-Sloan project to meet existing pumping energy needs.[211] However, as the DEIS acknowledges, Pick-Sloan energy may be available to meet the increasing pumping energy requirements of the no-weir alternatives.[212] The DEIS estimates that use of Pick-Sloan energy would reduce pumping costs by 41.15-67.34 percent.[213] That would reduce the cost of the Multiple Pump Alternative by $0.160 million to $0.262 million per year,[214] or about 1.6-2.6 percent of the entire annualized Multiple Pump Alternative cost of just under $10 million[215] per year. It would reduce the annual cost of pumping energy if only three pump sites were used, by $0.149 - $0.243 million per year,[216] or up to 3 percent of the entire annualized cost of just under $8 million per year.[217] Thus, use of Pick-Sloan power could reduce the cost per sturgeon AAHU of the Multiple Pump Alternative by up to $21/sturgeon AAHU,[218] and could reduce the cost per sturgeon AAHU of using three pump sites by up to $20/sturgeon AAHU.[219]

E. Use of wind energy for pumping energy

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[211] DEIS, pp. 2-24, 2-37, 3-14.
[212] DEIS, p. 2-75.
[213] Ibid. Reduction from $500,000 to $163,317 equals (500,000-163,317)/500,000 = .6734 = 67.34%. Reduction from $500,000 to $294,251 = (500,000 – 294,251)/500,000 = .4115 = 41.15%.
[214] Expected pumping costs of $389,000 (section V.B.1.e, above) x 41.15% reduction = $0.160 million reduction. $389,000 x 67.34% reduction = $0.262 million.
[215] $9.949 million per year adjusted annualized cost, per attached spreadsheet, “Multiple Pump costs” tab, line 17.
[216] Expected pumping costs of $361,000 (section VI.C.3.b, above) x 41.15% reduction = $0.149 million. $361,000 x 67.34 percent reduction = $0.243 million reduction from use of Pick Sloan energy.
[217] $0.243 million / 7.985 million = .0304 = 3.04%.
[218] $0.262 million / 12,319 sturgeon HUs (attached spreadsheet, “Cost per AAHU tab, line 3) = $21.27/sturgeon AAHU.
[219] $0.243 million / 12,319 sturgeon HUs (attached spreadsheet, “Cost per AAHU tab, line 3) = $19.73/sturgeon AAHU.

The DEIS includes the cost of wind generation in the Conservation Measures Alternative,[220] and indicates the agencies have the authority to build, operate, and maintain wind turbines to provide pumping energy.[221] The DEIS forecasts a capital cost for a 2 Mw wind turbine of more than $2.7 million per Mw of capacity,[222] which seems high given the recent approvals of two North Dakota wind farms consisting of 1.7 – 2.1 Mw turbines for $1.64 - $1.67 million per Mw.[223] Given the rapid development of wind resources in western North Dakota,[224] there seems to be little doubt that wind energy is a viable alternative source of supply for pumping energy.

VIII. Other issues

The analysis above focuses on the costs, the DEIS's habitat calculations, and cost effectiveness (as defined by the DEIS) of the Bypass Channel and Multiple Pumps Alternatives, and potentially modifying the Multiple Pumps Alternative to include three pump sites rather than five. It does not include a page-by-page review of the DEIS for errors or inconsistencies. However, a few such items are worth pointing out.

A. FPCI calculation for the Multiple Pumps alternative

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[220] Appendix B, pdf p. 94 of 173, line 9.
[221] DEIS, p. 2-92.
[222] Appendix B, pdf p. 94 of 173, lines 9, 13 and 14. $4.686 million x 1.01 (for adaptive management), plus $3.584 million x 1.01 x .15 x 1.2652 (for planning, engineering, construction, construction management, and associated contingency) = $5.420 million, or $2.71 million per Mw.
[223] http://bismarcktribune.com/bakken/western-north-dakota-in-the-midst-of-a-wind-boom/article_e32568d7-4fc3-5f66-babf-e8395fa7babb.html, a news story dated June 16, 2016 describing the permit approval of a 150 Mw windfarm containing 87 turbines for $250 million. 150 Mw/87 turbines = 1.72 Mw/turbine. $250 million / 150 Mw = $1.667 million / Mw.
See also http://bismarcktribune.com/news/state-and-regional/north-dakota-panel-approves-proposed-million-wind-farm/article_894783bd-b3c1-5598-87a3-0b1a829c319d.html, a news story dated June 22, 2016, describing the permit approval of a different North Dakota wind farm, containing 48 turbines and producing 100 Mw, for a capital cost of $164.4 million including transmission. 100 Mw / 48 turbines = 2.08 Mw / turbine. $164.4 million / 100 Mw = $1.644 million per turbine.
[224] Ibid., describing western North Dakota as having 400 wind turbines in service that were installed in the last ten years ,and another 550 proposed for the next two years. The articles names seven specific projects with a combined capacity over 1250 Mw that form the basis for the estimated 550 new wind turbines to be built by 2018.
See also http://bismarcktribune.com/wind-farm-projects/pdf_7f769038-c4a4-596a-bc02-244b27b81b35.html, a map showing the locations of 9 western North Dakota projects (including an MDU project) with in-service dates from 2010 to 2018, totaling 903 turbines and 2223 turbines (average turbine size 2.46 Mw).

The Fish Passage Connectivity Index (FPCI) is one of the two parameters that, when multiplied together, yield the "Habitat Units" measure that the DEIS uses to evaluate the environmental impacts on sturgeon passage. Thus the FPCI is key to evaluating and comparing the alternatives in the DEIS. The FPCI is in turn calculated from just four inputs. One of those inputs, known as Fs, is a measure of the likelihood of fish using the passage option available to them in a particular Alternative. Fs is measured on a scale of 1 to 5 with 5 being the highest likelihood. For a no-weir alternative, Fs should be 5, and the DEIS indeed reports it as 5 for the no-weir alternative using conservation measures.[225] However, the Fs input is shown as 2 in the DEIS for the Multiple Pumps Alternative.[226] Since the DEIS does not show the calculation of the FPCI for sturgeon (or indeed for any other individual species), it is unclear whether the actual FPCI calculations for the Multiple Pumps Alternative used an Fs value of 2 or 5.

B. Dam removal costs

The DEIS contains two alternatives in which the existing Intake Dam is removed. However, the forecasted cost of dam removal is quite different for the two alternatives. For the Multiple Pump Alternative, dam removal costs are given as $6.600 million plus a 45.02 percent contingency, for a total of $9.571 million.[227] But for the Conservation Measures Alternative, dam removal costs are stated as $2.534 million, again with a 45.02 percent contingency, for a total of $3.675 million.[228] The use of the identical contingency percentage shows that dam removal refers to the same activity for both alternatives, as does the fact that the dam removal section for the Multiple Pump Alternative simply references the Conservation Measures Alternative.[229] Equally clearly, at least one of the estimates is wrong. As it turns out, the estimate for the Multiple Pump Alternative is the higher one, by $5.896 million,[230] and has been used without adjustment in the analysis

[225] Appendix D, p. 12.
[226] Ibid.
[227] Appendix B, pdf p. 84 of 173, line 1.
[228] Appendix B, pdf p. 94 of 173, line 3.
[229] Appendix A, pdf p. 219 of 527.
[230] $9.571 million minus $3.675 million equals $5.896 million.

above. But if the correct dam removal cost estimate is the lower one, then the Multiple Pump Alternative using three or five pump sites would be less expensive, by about $280,000 per year,[231] and thus have about a $23 lower annual cost per sturgeon HU,[232] and thus be more cost-effective.

C. Boulder field removal costs

Decades of ice scouring have moved rocks from the top of the Intake Dam to the bed of the Yellowstone River downstream, resulting in a substantial boulder field on the river bottom downstream of the dam. The dam removal costs for the two no-weir alternatives in the DEIS include the cost to remove not just the dam itself, but also the boulder field downstream of it.[233] The boulder field removal represents 93.6 percent of the total material to be removed from the Yellowstone River as part of "dam removal,"[234] and thus presumably represents close to 93% of the cost as well.

The DEIS does not appear to have any explanation of whether full removal of the boulder field is necessary to allow sturgeon passage up the main channel of the Yellowstone River after dam removal. However, assuming that **any** boulders remaining on the riverbed represent a threat to sturgeon passage,[235] then the DEIS should have included a discussion of the risk and cost for the Bypass Channel Alternative of leaving the boulder field intact. The DEIS says only that the proposed new concrete dam would cause the addition of new rocks on top of Intake Dam to cease.[236] It appears to say

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[231] Reducing their direct cost by $6.600 - $2.534 = $4.066 million would reduce the associated, planning, engineering, design and construction management costs by $4.066 million x .15 = $0.610 million, or $0.610 x 1.2652 = $0.772 million including contingency. Reducing capital costs by $5.896 + $0.772 million = $6.668 million would reduce total first costs by another 1% ($0.067 million) due to habitat management costs during construction, for a total first cost reduction of $6.668 + $0.067 = $6.735 million. Interest during construction is equal to 6.557/132.028 = 4.966% of first costs (DEIS, p. xxxii, Table ES-1), for a total investment cost of $6.735 x 1.04966 = $7.069 million. Annualized investment costs are equal to $5.515/$138.585 = 3.980% of investment costs, so an investment cost reduction of $7.069 million equates to an annualized investment cost reduction of $7.069 million x .0398 = $0.281 million per year.

[232] An annualized cost reduction of $281,000 for a no-weir alternative equates to a reduction in the cost per sturgeon HU of $281,000/12,319 sturgeon HU = $23/sturgeon AAHU.

[233] Appendix B, pdf p. 126 of 173, showing that even the less expensive (per comparison of pdf pp. 94 and 84) Conservation Measures Alternative involves removal of downstream boulders.

[234] Ibid. 42,264 cubic yards/(42,264+2,904) cubic years = 93.6%.

[235] As suggested by the DEIS, p. 2-108. See also Battelle, p. A-6, indicating that "pallid sturgeon are known to avoid" the "boulder-sized substrates near Intake Diversion Dam."

[236] DEIS, p. 2-46.

nothing about what would happen to the existing century worth of rocks that are already in the river, and have already migrated up to 370 feet[237] downstream from the dam where they were originally placed. The DEIS does acknowledge that removing some or all of the existing boulder field is a possible future action in response to the results of monitoring.[238]

D. Role of contingency adders in the cost analysis

The DEIS estimates the total construction cost of the Multiple Pump Alternative as $97.492 million, and then adds total contingency estimates of $34.535 million, to get a total cost of $132.027 million.[239] Thus, over 26 percent of the capital cost of the Multiple Pump Alternative is contingency costs.[240] The comparable figure for the Bypass Channel Alternative is only 8.1 percent.[241] Thus a substantial part of the reason why the DEIS concludes that the Multiple Pump Alternative is not as cost-effective as the Bypass Channel Alternative[242] is the greater uncertainty associated with its capital costs.

In effect, the DEIS penalizes the Multiple Pump Alternative for the fact that the Federal Agencies had previously decided to pursue the Bypass Channel Alternative, and thus have spent money designing it and pricing it.[243] Then they use the fact that they have not given the Multiple Pump Alternative as much scrutiny in the past as a reason to reject it in the present.

E. Water losses in the Main Canal

The DEIS claims water losses from the Main Canal are “minimal.”[244] That claim is false, and is based on cherry-picking of data. While the error does not affect any of the

[237] Appendix A, pdf p. 370 of 527.
[238] Appendix E, p. 16.
[239] Appendix B, pdf p. 84 of 173, lowest highlighted line.
[240] $34.535 / $132.027 = .262 = 26.2%.
[241] Appendix B, pdf p. 65 of 173. $4.624 million of contingency / $57.044 million total cost = 8.1 percent.
[242] DEIS, p. 2-100.
[243] Indeed, the DEIS doesn’t count as part of the cost of the Bypass Channel Alternative the money, probably millions of dollars, that has already been spent on it. DEIS, p. 2-98, Table 2-25 and its footnote a.
[244] DEIS, p. 2-93.

conclusions of either the DEIS or this analysis, it casts doubt on the impartiality of the DEIS authors.

Specifically, the analysis underlying the “minimal” claim is found at the end of Appendix A, in tables showing daily diversions and daily Main Canal losses for the years 2000 and 2012.[245] It shows that on days when diversions were above 1300 cfs, the highest diversion days of the year, losses from the Main Canal averaged 20.4 percent during 17 days in 2000 and 16.3 percent during 20 days in 2012. The year 2000 loss rate of 20.4 percent during those high diversion days were almost as high as the annual average loss rate of 23.3 percent for the year 2000. The loss during the high diversion days in 2012 was 16.3 percent, **higher** than the 15.5 percent loss rate for the year as a whole. Annual loss rates of 15-23 percent are hardly minimal, loss rates of 16-20 during days when diversions at Intake exceed 1300 cfs are not either, and claims that loss rates go down substantially when diversion rates are high are contradicted by the evidence.

F. O&M costs and viability/sustainability

The DEIS lists only four reasons for preferring the Bypass Channel Alternative, one of which is its claimed lower operation and maintenance (O&M) costs.[246] The table cited by the DEIS shows “Annualized OM&R” costs that are $2.799 million for the Bypass Channel Alternative and $5.034 million for the Multiple Pumps Alternative,[247] for a difference of $2.235 million per year.

The $2.235 million figure is overstated. First, part of the $2.235 million is likely not O&M at all, but rather is replacement costs. Those replacement costs include costs such as pump replacements that are capital costs that are incurred only once per 35 years.[248] The difference between the Bypass Channel and Multiple Pumps Alternatives for just O&M is $1.557 – 1.941 million.[249]

[245] Appendix A, pdf pp. 472-474 (year 2000 daily data) and 478-480 (year 2012 daily data).
[246] DEIS, p. 2-105.
[247] DEIS, p. 2-99, Table 2-26.
[248] See the attached spreadsheet, “O&M Costs” tab, which summarizes data from Attachment B-8 to Appendix B of the DEIS, pdf pp. 9-10 of 19 (Bypass Channel Alternative) and pdf pp. 15-16 of 19 (Multiple Pump Alternative).
[249] Ibid., lines 44-45.

Second, the $2.235 million omits the "moderately potential"[250] cost of adaptive management for the Bypass Channel Alternative, and includes unnecessary costs for the Multiple Pumps Alternative. The omitted costs for the Bypass Channel Alternative were estimated above as $0.085 million per year,[251] while the O&M costs for the Multiple Pumps Alternative are overstated by between $0.289 million[252] and $0.909 million.[253] Thus the $2.235 million difference should be corrected to $1.241 - $1.861 million.[254]

Third, the $2.235 million difference omits the possible O&M reduction for the Multiple Pumps Alternative from use of Pick-Sloan power, which could save a further $0.143 - $0.262 million.[255]

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[250] DEIS, p. 2-103. By contrast, the DEIS expects the Multiple Pumps Alternative to have a "minimal need" for adaptive management.
[251] Section IV.A.1, assuming the "moderate" likelihood results in adaptive management costs only half as large as the potential cost estimated in the 2015 EA.
[252] See the attached spreadsheet, "Multiple Pump costs" tab, line 14.
[253] See the attached spreadsheet, "Three Pump Sites cost" tab, line 20.
[254] $2.235 million minus $0.085 million minus either $$0.909 million or $0.289 million.
[255] See section VII.D, above.